REMARKS/ARGUMENTS

Claims 1-6, 8-13 and 15-26 are active. Claims 15, 19 and 25 are withdrawn. Claim 26 is constructively withdrawn.

The claimed invention provides a photovoltaic device having a composition of carbon nanotubes and of at least one organic hole conductor, which is useful for generating electricity from light. According to the claimed invention, the band gap of the carbon nanotubes lies in the range of from about 0.5 to about 1 eV and therefore lower energy light in comparison to conventional photovoltaic devices is absorbed and converted to electrical energy. Therefore, the photovoltaic devices according to the claimed invention are more efficient in terms of energy conversion, and are advantageously produced from relatively low cost organic materials.

Applicants have described the significant improvement in conversion of lower energy light to electricity on page 10, lines 1-10, in the specification as follows:

> The present invention provides for a network of electron- and hole-acceptors (and therefore also hole- and electron-donors) combining both a good charge carrier transfer from the donors to the acceptors and a good carrier mobility within the constituents of the network.
>
> It furthermore provides for **a more effective absorption of light in the visible and near- infrared region, which distinguishes the devices according to the present invention from the devices of the prior art, e. g. organic solar cells based on fullerenes.** The absorption spectra of the latter are centered in the short wavelength region of the visible spectra and therefore, without wanting to be bound by any mechanistic theory, show minor power conversion efficiencies. (Bold added)

Since the band gap of the organic hole conductor is about 2 eV, i.e., is significantly larger than the band gap of the carbon nanotube system, the claimed photovoltaic covers a much wider range of photon energies. Therefore, the claimed device is better adjusted to the

different spectra of commonly available light sources and will provide more efficient conversion of light, independent of the irradiation source, than conventional solar devices.

The rejection of Claims 1, 3-4, 7-8, 11 16-17 and 23-24 under 35 U.S.C. 102(b) or in the alternative under 35 U.S.C. 103(a) over Ago et al.("Composites of Carbon Nanotubes and Conjugated Polymers for Photovoltaic Devices," Advanced Materials, VCH Verlagsgesellschaft, Weinheim, DE, vol. 11, no.15, 20 October 1999 (1999-10-20), pages 1281-1285)("Composites") with support of Ago et al. ("Electronic interaction between photoexcited poly(p-phenylene vinylene) and carbon nanotubes," Physical Review B, Vol. 61, No. 3, 15 January 2000, 2286-2290)("Electronic interaction) is respectfully traversed.

Applicants respectfully note that Ago ("Electronic interaction") is cited as a "teaching reference," on page 4, line 14, of the above identified Official Action. However, no direct citing of this reference is made.

The Office has stated (Official Action dated October 20, 2008, page 4, lines 16-23):

> Ago et al (Composites also discloses MWNT as small-gap semiconductors (the activation energy (i.e., band gap) is 3-14 meV . . . . As ling as the band-gap of the carbon nanotube is smaller than the one of the organic hole conductor, a photovoltaic effect will be observed. In addition, the specification of the present application does not mention any unexpected results for a band-gap of 0.5 eV – 1 eV.

Applicants respectfully note that the claimed invention describes a band gap of from 0.5 to 1.0 eV and Applicants have described that according to the claimed device, lower energy light in comparison to conventional photovoltaic devices is absorbed and converted to electrical energy. Applicants respectfully submit that such significant improvement in light energy conversion to electrical energy sufficiently supports the patentability of the claimed invention.

Moreover, regarding Ago (Composites) disclosing MWNT as small-gap semiconductors, Applicants again respectfully point to the description in the cited reference, beginning at line 5 in column 2 to understand the reference description.

> "The structure of the photovoltaic devices is shown in Figure 4a, where PPV and MWNT layers have 210 and 140 nm thickness respectively. **The MWNT layer was used as the hole-collecting electrode, because of its relatively high conductivity (8 S/cm at room temperature)[13] and high work function (5.1 eV)[16].**" (Bold and underline added)

Applicants respectfully submit that nowhere does this combination of references disclose or suggest carbon nanotubes having a band gap in the range of from about 0.5 to about 1 eV., and nowhere does this combination of references describe the MWNT layer as the layer intermediate between the two electrodes as according to the claimed invention.

Applicants respectfully submit that Claims 3-4, 7-8, 11, 16-17 and 23-24, all directly or indirectly depend from Claim 1, and therefore include the patentable subject matter described in Claim 1.

In view of all the above, withdrawal of the rejection of Claims 1, 3-4, 7-8, 11 16-17 and 23-24 under 35 U.S.C. 102(b) or in the alternative under 35 U.S.C. 103(a) over Ago (Composites) with support of Ago ("Electronic Interaction") is respectfully requested.

The rejection of Claims 2, 6, 9-10, 12-13, 18 and 21-22 under 35 U.S.C. 103(a) over over Ago (Composites) with support of Ago ("Electronic Interaction") and further in view of Kymakis et al. ("Single-Wall Carbon Nanotube/Conjugated Polymer Photovoltaic Devices," Applied Physics Letters, American Institute of Physics. New York, Us vol. 80, no. 1, 7, pages 112-114) is respectfully traversed.

Applicants respectfully note that Claims 2, 6, 9-10, 12-13, 18 and 21-22, all directly or indirectly depend from Claim 1. The deficiencies of the primary combination of references relative to Claim 1 and claims dependent thereon have been described above.

Kymakis describes a photovoltaic device containing poly(3-octylthiophene) and single walled carbon nanotubes. Fig. 2 shows the Absorption spectra of the composite and in discussing the spectra, states:

> "The absorption spectra of the P3OT show no significant change upon adding 1% of nanotubes by weight. This implies that in the blend, no significant ground state interaction is taking place between the two materials, . . . From the absorption spectra of the P3OT, an optical band gap of 2.4 eV can be derived."

Further, on page 114, left column, lines 16-25, Kymakis describes that the workfunction of SWNTs ranges from 3.4 to 4 eV. Nowhere does this reference disclose or suggest carbon nanotubes having a band gap from about 0.5 to about 1 eV., and therefore this cited reference cannot cure the deficiencies of the cited primary references.

In view of the foregoing, Applicants respectfully submit that the cited combination of references can neither anticipate nor render obvious the claimed invention, and withdrawal of the rejection of Claims 2, 6, 9-10, 12-13, 18 and 21-22 under 35 U.S.C. 103(a) over Ago (Composites) with support of Ago ("Electronic Interaction") and further in view of Kymakis is respectfully requested.

The rejection of Claim 5 under 35 U.S.C. 103(a) over Ago (Composites) with support of Ago ("Electronic Interaction") and further in view of Tsukamoto et al. (JP 2003-096313) is respectfully traversed.

Tsukamoto describes a Field Effect Transitor wherein a composite of carbon nanotubes and organic polymer is used as a semiconductor.

Applicants respectfully note that Claim 5 directly depends from Claim 1.

Tsukamoto is cited to show carbon nanotubes being a mixture of multi-walled and single-walled carbon nanotubes. This reference is silent with respect to a band gap for the carbon nanotubes and as previously discussed (Response to Official Action dated April 24, 2008, filed August 25, 2008), carbon nanotubes are generally known to have band gaps of 3

eV or higher. Accordingly, Applicants respectfully submit that this secondary reference neither discloses nor suggests a device having carbon nanotubes with a band gap which is in the range of from about 0.5 to about 1 eV.

In view of the above, Applicants respectfully submit that the cited secondary reference cannot cure the deficiencies of the primary reference combination. As the cited combination of references can neither anticipate nor render obvious the claimed invention, withdrawal of the rejection of Claim 5 under 35 U.S.C. 103(a) over Ago (Composites) with support of Ago ("Electronic interaction") and further in view of Tsukamoto is respectfully requested.

The rejection of Claim 12 under 35 U.S.C. 103(a) over Ago (Composites) with support of Ago ("Electronic interaction") and further in view of Forrest et al. (U.S. 6,451,415) is respectfully traversed.

Claim 12 directly depends from Claim 1 and the deficiencies of each of the cited primary reference combination is described above. Forrest is cited to show a multilayer structure. This reference describes photodetector organic photosensitive optoelectronic devices having multilayer structures and an exciton blocking layer. However, Forrest does not disclose or suggest multilayers containing carbon nanotubes having a band gap in the range of from about 0.5 to about 1 eV., and therefore, cannot cure the deficiencies of the primary reference combination. Accordingly, withdrawal of the rejection of Claim 12 under 35 U.S.C. 103(a) over Ago (Composites) with support of Ago ("Electronic interaction") and further in view of further in view of Forrest is respectfully requested.

The rejection of Claim 20 under 35 U.S.C. 103(a) over Ago (Composites) with support of Ago ("Electronic interaction"), further in view of Kymakis and further in view of Ganzorig et al. (Alkali metal acetates as effective electron injection layers for organic electroluminescent device," Materials Science and Engineering B, Elsevier Sequoia,

Lausanne, Ch, vol. 85 no. 2-3, 22 August 2001 (2001-08-22), pages 140-143) is respectfully traversed.

Ganzorig is cited to show the addition of an LiF, CsF or Li acetate interlayer between the Al electrode and the organic hole conducting compound layer. Applicants respectfully submit that nowhere does Ganzorig disclose or suggest a composite of carbon nanotubes and of at least one organic hole conductor, wherein the band gap of the carbon nanotubes lies in the range of from about 0.5 to about 1 eV., and therefore does not cure the basic deficiency of the primary reference combination. Accordingly, withdrawal of the rejection of Claim 20 under 35 U.S.C. 103(a) over Ago (Composites) with support of Ago ("Electronic interaction"), further in view of Kymakis and further in view of Ganzorig is respectfully requested.

The constructive restriction of Claim 26 is respectfully traversed.

U.S.C. 37 C.F.R. § 1.475 (b)(3) states, in pertinent part:

> An international or a national stage application containing claims to different categories of invention will be considered to have unity of invention if the claims are drawn only to one of the following combinations of categories:
> (3) A product, a process specially adapted for the manufacture of said product and a use of said product; . . .

Applicants respectfully submit that the Office has not considered U.S.C. 37 C.F.R. § 1.475 (b)(3) and therefore has failed to meet the burden necessary in order to sustain the requirement for restriction. Applicants therefore request that the requirement for restriction be withdrawn.

The objection to the drawings under 37 CFR 1.83(a) is respectfully traversed.

Applicants respectfully call the Examiner's attention to 37 CFR 1.81 (b) which states:

> Drawings may include illustrations which facilitate an understanding of the invention (for example, flow sheets in cases of processes, and diagrammatic views).

Applicants respectfully submit that Figs. 1 and 2 facilitate an understanding of the invention and therefore according to 37 CFR 1.81 (b), should be acceptable under 37 CFR 1.83. Accordingly, withdrawal of the objection to the drawings under 37 CFR 1.83(a) is respectfully requested.

Applicants respectfully submit that the above-identified application is now in condition for allowance and early notice of such action is earnestly solicited.

Respectfully submitted,

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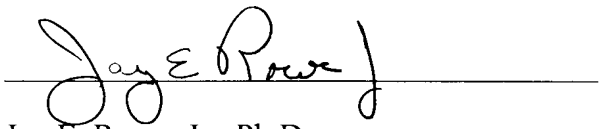

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